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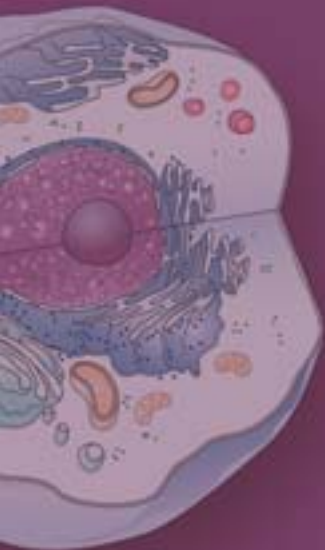
The Body as a Whole

*T*his unit presents the basic levels of organization within the human body. Included is a description of the smallest units of life, called cells. Similar cells are grouped together as tissues, which are combined to form organs. Organs, in turn, work together in the various body systems, which together satisfy the needs of the entire organism. A short survey of chemistry, which deals with the composition of all matter and is important for the understanding of human physiology, is incorporated into this unit. These chapters prepare the student for the more detailed study of individual body systems in the units that follow.

SELECTED KEY TERMS

The following terms and other boldface terms in the chapter are defined in the Glossary

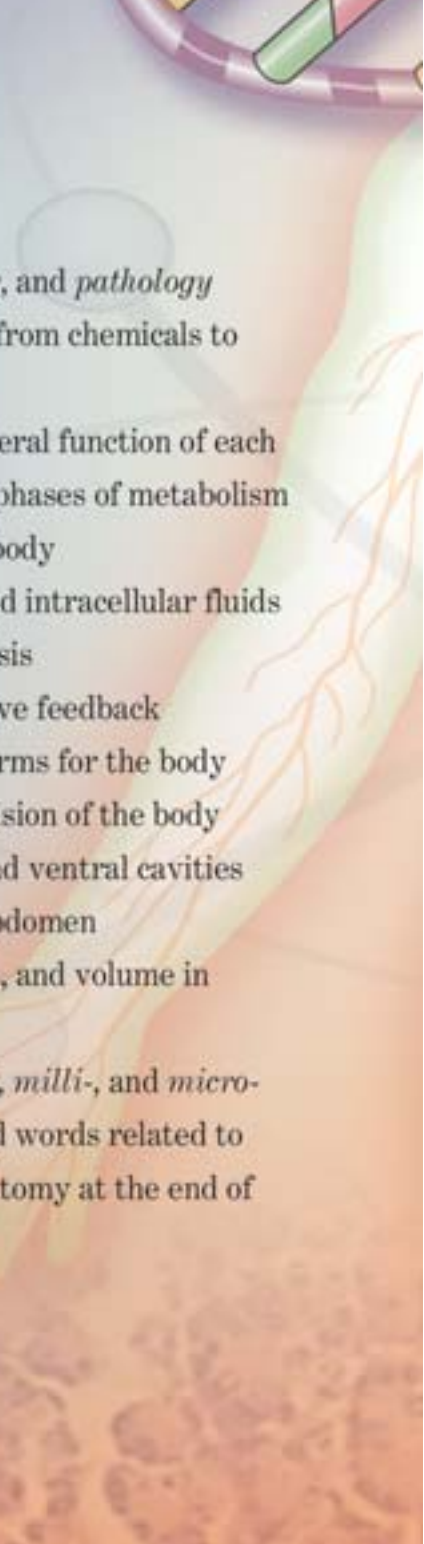
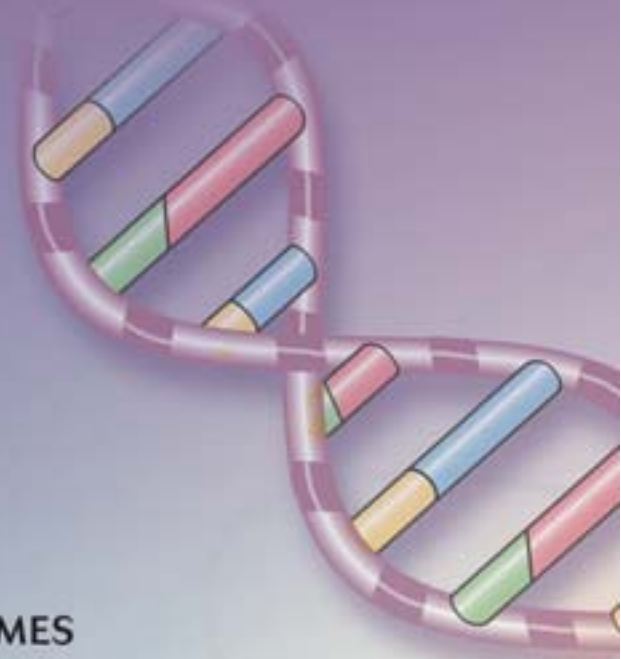
anabolism
anatomy
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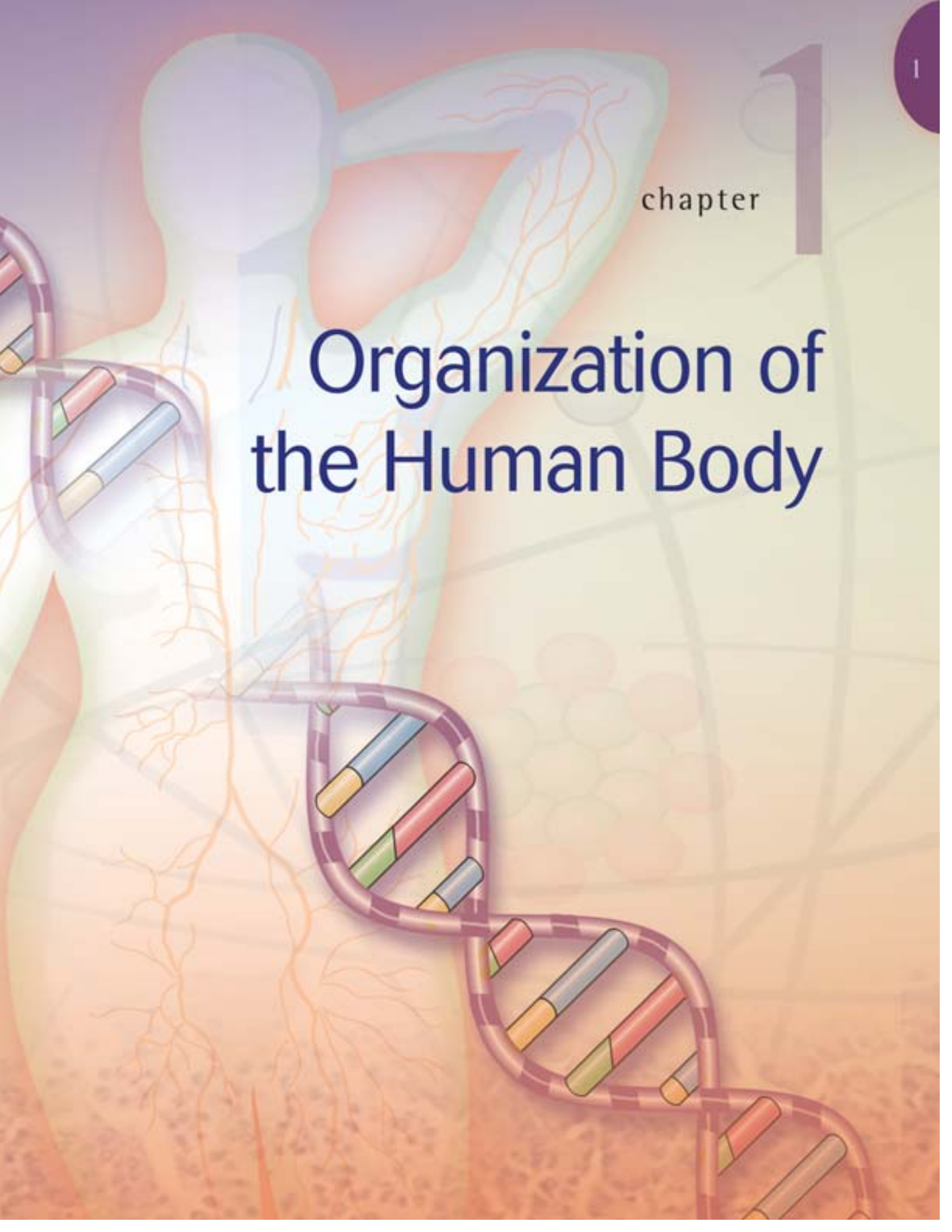


LEARNING OUTCOMES

After careful study of this chapter, you should be able to:

1. Define the terms *anatomy*, *physiology*, and *pathology*
2. Describe the organization of the body from chemicals to the whole organism
3. List 11 body systems and give the general function of each
4. Define *metabolism* and name the two phases of metabolism
5. Briefly explain the role of ATP in the body
6. Differentiate between extracellular and intracellular fluids
7. Define and give examples of homeostasis
8. Compare negative feedback and positive feedback
9. List and define the main directional terms for the body
10. List and define the three planes of division of the body
11. Name the subdivisions of the dorsal and ventral cavities
12. Name and locate subdivisions of the abdomen
13. Name the basic units of length, weight, and volume in the metric system
14. Define the metric prefixes *kilo-*, *centi-*, *milli-*, and *micro-*
15. Show how word parts are used to build words related to the body's organization (see Word Anatomy at the end of the chapter)





chapter

Organization of the Human Body

Studies of the normal structure and functions of the body are the basis for all medical sciences. It is only from understanding the normal that one can analyze what is going wrong in cases of disease. These studies give one an appreciation for the design and balance of the human body and for living organisms in general.

▮ Studies of the Human Body

The scientific term for the study of body structure is **anatomy** (ah-NAT-o-me). The *-tomy* part of this word in Latin means “cutting,” because a fundamental way to learn about the human body is to cut it apart, or **dissect** (dis-sekt) it. **Physiology** (fiz-e-OL-o-je) is the term for the study of how the body functions, and is based on a Latin term meaning “nature.” Anatomy and physiology are closely related—that is, form and function are intertwined. The stomach, for example, has a pouch-like shape because it stores food during digestion. The cells in the lining of the stomach are tightly packed to prevent strong digestive juices from harming underlying tissue. Anything that upsets the normal structure or working of the body is considered a **disease** and is studied as the science of **pathology** (pah-THOL-o-je).

Levels of Organization

All living things are organized from very simple levels to more complex levels (Fig. 1-1). Living matter is derived from simple chemicals. These chemicals are formed into the complex substances that make living cells—the basic units of all life. Specialized groups of cells form **tissues**, and tissues may function together as **organs**. Organs working together for the same general purpose make up the **body systems**. All of the systems work together to maintain the body as a whole organism.

Checkpoint 1-1 In studying the human body, one may concentrate on its structure or its function. What are these two studies called?

▮ Body Systems

Most studies of the human body are organized according to the individual systems, as listed below, grouped according to their general functions.

- ▮ Protection, support, and movement
 - ▮ The **integumentary** (in-teg-u-MEN-tar-e) system. The word *integument* (in-TEG-u-ment) means skin. The skin with its associated structures is considered a separate body system. The structures associated with the skin include the hair, the nails, and the sweat and oil glands.
 - ▮ The **skeletal system**. The basic framework of the body is a system of 206 bones and the joints between them, collectively known as the **skeleton**.

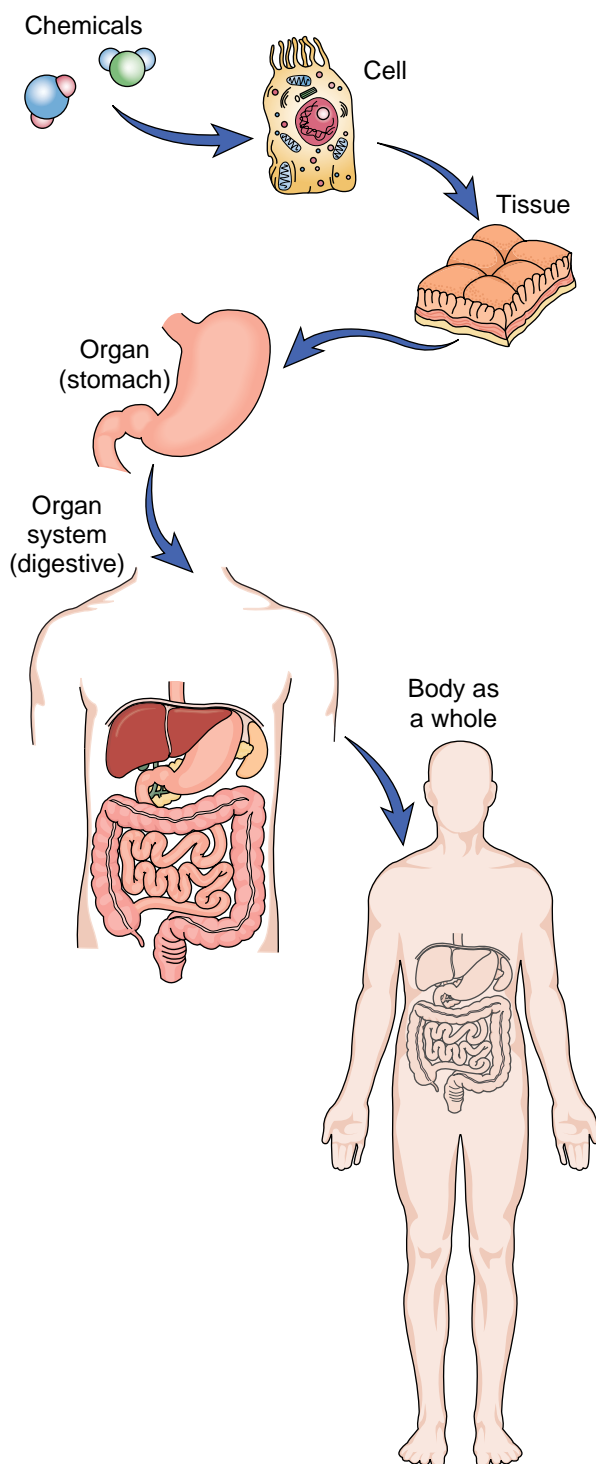


Figure 1-1 Levels of organization. The organ shown is the stomach, which is part of the digestive system.

- ▮ The **muscular system**. The muscles in this system are attached to the bones and produce movement of the skeleton. These skeletal muscles also give the body structure, protect organs, and maintain posture. The two other types of muscles are smooth muscle, present in the walls of body or-

gans, such as the stomach and intestine, and cardiac muscle, which makes up the wall of the heart.

- ▶ **Coordination and control**
 - ▶ The **nervous system**. The brain, the spinal cord, and the nerves make up this complex system by which the body is controlled and coordinated. The organs of special sense (the eyes, ears, taste buds, and organs of smell), together with the receptors for pain, touch, and other generalized senses, receive stimuli from the outside world. These stimuli are converted into impulses that are transmitted to the brain. The brain directs the body's responses to these outside stimuli and also to stimuli coming from within the body. Such higher functions as memory and reasoning also occur in the brain.
 - ▶ The **endocrine (EN-do-krin) system**. The scattered organs known as endocrine glands are grouped together because they share a similar function. All produce special substances called hormones, which regulate such body activities as growth, food utilization within the cells, and reproduction. Examples of endocrine glands are the thyroid, pituitary, and adrenal glands.
- ▶ **Circulation**
 - ▶ The **cardiovascular system**. The heart and blood vessels make up the system that pumps blood to all the body tissues, bringing with it nutrients, oxygen, and other needed substances. This system then carries waste materials away from the tissues to points where they can be eliminated.
 - ▶ The **lymphatic system**. Lymphatic vessels assist in circulation by bringing fluids from the tissues back to the blood. Organs of the lymphatic system, such as the tonsils, thymus gland, and the spleen, play a role in immunity, protecting against disease. The lymphatic system also aids in the absorption of digested fats through special vessels in the intestine. The fluid that circulates in the lymphatic system is called lymph. The lymphatic and cardiovascular systems together make up the circulatory system.
- ▶ **Nutrition and fluid balance**
 - ▶ The **respiratory system**. This system includes the lungs and the passages leading to and from the lungs. The purpose of this system is to take in air and conduct it to the areas designed for gas exchange. Oxygen passes from the air into the blood and is carried to all tissues by the cardiovascular system. In like manner, carbon dioxide, a gaseous waste product, is taken by the circulation from the tissues back to the lungs to be expelled.
 - ▶ The **digestive system**. This system comprises all the organs that are involved with taking in nutrients (foods), converting them into a form that body cells can use, and absorbing these nutrients into the circulation. Organs of the digestive system include the mouth, esophagus, stomach, intestine, liver, and pancreas.
 - ▶ The **urinary system**. The chief purpose of the urinary system is to rid the body of waste products and excess water. The main components of this system are the

kidneys, the ureters, the bladder, and the urethra. (Note that some waste products are also eliminated by the digestive and respiratory systems and by the skin.)

- ▶ **Production of offspring**
 - ▶ The **reproductive system**. This system includes the external sex organs and all related internal structures that are concerned with the production of offspring.

The number of systems may vary in different lists. Some, for example, show the sensory system as separate from the nervous system. Others have a separate entry for the immune system, which protects the body from foreign matter and invading organisms. The immune system is identified by its function rather than its structure and includes elements of both the cardiovascular and lymphatic systems. Bear in mind that even though the systems are studied as separate units, they are interrelated and must cooperate to maintain health.

▶ Metabolism and Its Regulation

All the life-sustaining reactions that go on within the body systems together make up **metabolism** (meh-TAB-o-lizm). Metabolism can be divided into two types of activities:

- ▶ In **catabolism** (kah-TAB-o-lizm), complex substances are broken down into simpler compounds (Fig. 1-2). The breakdown of the nutrients in food yields simple chemical building blocks and energy to power cell activities.
- ▶ In **anabolism** (ah-NAB-o-lizm), simple compounds are used to manufacture materials needed for growth, function, and repair of tissues. Anabolism is the building phase of metabolism.

The energy obtained from the breakdown of nutrients is used to form a compound often described as the “energy currency” of the cell. It has the long name of **adenosine triphosphate** (ah-DEN-o-sene tri-FOS-fate), but is

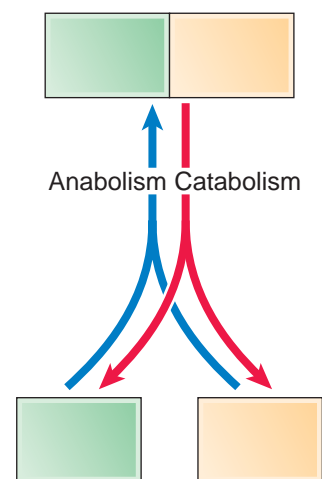


Figure 1-2 Metabolism. In catabolism substances are broken down into their building blocks. In anabolism simple components are built into more complex substances.

Box 1-1 Clinical Perspectives

Homeostatic Imbalance: When Feedback Fails

Each body structure contributes in some way to homeostasis, often through feedback mechanisms. The nervous and endocrine systems are particularly important in feedback. The nervous system's electrical signals react quickly to changes in homeostasis, while the endocrine system's chemical signals (hormones) react more slowly but over a longer time. Often both systems work together to maintain homeostasis.

As long as feedback keeps conditions within normal limits, the body remains healthy, but if feedback cannot maintain these conditions, the body enters a state of *homeostatic imbalance*. Moderate imbalance causes illness and disease, while severe imbalance causes death. At some level, all illnesses and diseases can be linked to homeostatic imbalance.

For example, feedback mechanisms closely monitor and maintain normal blood pressure. When blood pressure rises, negative feedback mechanisms lower it to normal limits. If these mecha-

nisms fail, *hypertension* (high blood pressure) develops. Hypertension further damages the cardiovascular system and, if untreated, may lead to death. With mild hypertension, lifestyle changes in diet, exercise, and stress management may lower blood pressure sufficiently, whereas severe hypertension often requires drug therapy. The various types of antihypertensive medication all help negative feedback mechanisms lower blood pressure.

Feedback mechanisms also regulate body temperature. When body temperature falls, negative feedback mechanisms raise it back to normal limits, but if these mechanisms fail and body temperature continues to drop, *hypothermia* develops. Its main effects are uncontrolled shivering, lack of coordination, decreased heart and respiratory rates, and, if left untreated, death. Cardiac surgeons use hypothermia to their advantage during open-heart surgery by cooling the body. This stops the heart and decreases its blood flow, creating a motionless and bloodless surgical field.

commonly abbreviated ATP. Chapter 20 has more information on metabolism and ATP.

Homeostasis

Normal body function maintains a state of internal balance, an important characteristic of all living things. Such conditions as body temperature, the composition of body fluids, heart rate, respiration rate, and blood pressure must be kept within set limits to maintain health. (See Box 1-1, Homeostatic Imbalance: When Feedback Fails.) This steady state within the organism is called **homeostasis** (ho-me-o-STA-sis), which literally means “staying (stasis) the same (homeo).”

Fluid Balance Our bodies are composed of large amounts of fluids. The amount and composition of these fluids must be regulated at all times. One type of fluid bathes the cells, carries nutrient substances to and from the cells, and transports the nutrients into and out of the cells. This type is called **extracellular fluid** because it includes all body fluids outside the cells. Examples of extracellular fluids are blood, lymph, and the fluid between the cells in tissues. A second type of fluid, **intracellular fluid**, is contained within the cells. Extracellular and intracellular fluids account for about 60% of an adult's weight. Body fluids are discussed in more detail in Chapter 21.

Feedback The main method for maintaining homeostasis is **feedback**, a control system based on information returning to a source. We are all accustomed to getting feedback about the results of our actions and using that information to regulate our behavior. Grades on tests and assignments, for example, may inspire us to work harder if they're not so great or “keep up the good work” if they are good.

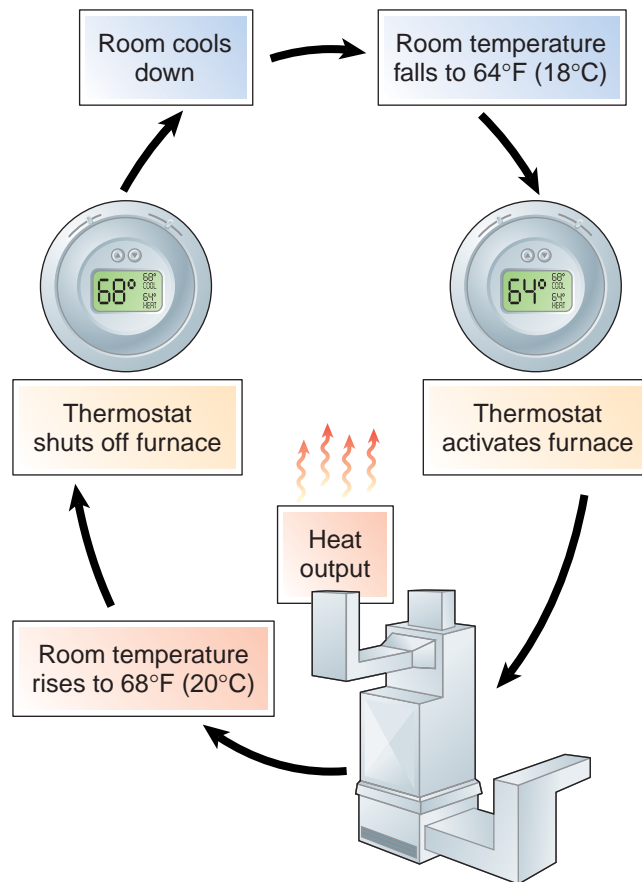


Figure 1-3 Negative feedback. A home thermostat illustrates how this type of feedback keeps temperature within a set range.

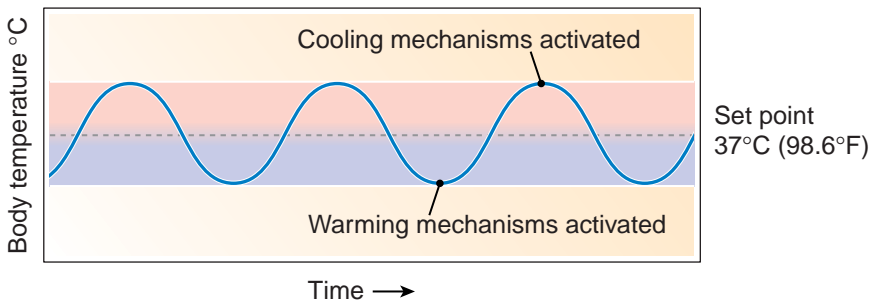


Figure 1-4 Negative feedback and body temperature. Body temperature is kept at a set point of 37° C by negative feedback acting on a center in the brain.

Most feedback systems keep body conditions within a set normal range by reversing any upward or downward shift. This form of feedback is called **negative feedback**, because actions are reversed. A familiar example of negative feedback is the thermostat in a house (Fig. 1-3). When the house temperature falls, the thermostat triggers the furnace to turn on and increase the temperature; when the house temperature reaches an upper limit, the furnace is shut off. In the body, a center in the brain detects changes in temperature and starts mechanisms for cooling or warming if the temperature is above or below the average set point of 37° C (98.6° F) (Fig. 1-4).

As another example, when glucose (a sugar) increases in the blood, the pancreas secretes insulin, which causes body cells to use more glucose. Increased uptake of glucose and the subsequent drop in blood sugar level serves as a signal to the pancreas to reduce insulin secretion

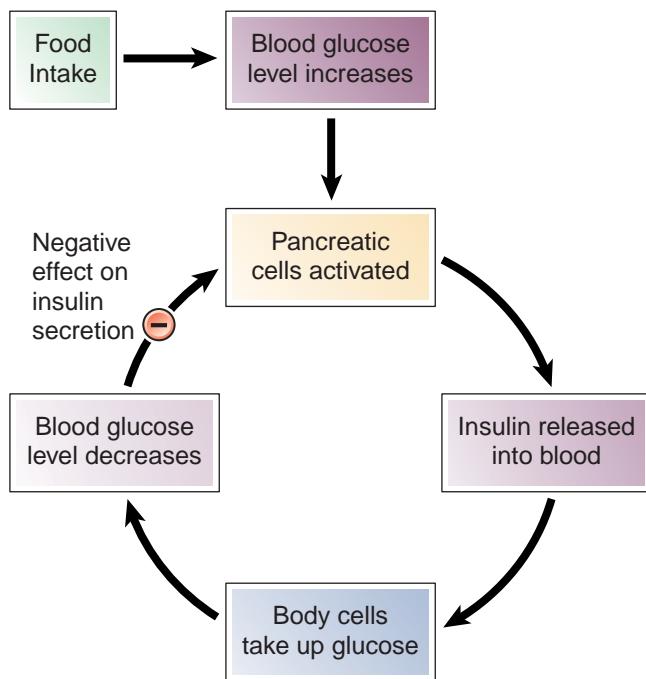


Figure 1-5 Negative feedback in the endocrine system. Glucose utilization regulates insulin production by means of negative feedback.

(Fig. 1-5). As a result of insulin’s action, the secretion of insulin is reversed. This type of self-regulating feedback loop is used in the endocrine system to maintain proper levels of hormones, as described in Chapter 12.

A few activities involve **positive feedback**, in which a given action promotes more of the same. The process of childbirth illustrates positive feedback. As the contractions of labor begin, the muscles of the uterus are stretched. The stretching sends nervous signals to the pituitary gland to release the hormone oxytocin into the blood. This hormone stimulates further contractions of the uterus. As contractions increase in force, the uterine muscles are stretched even more, causing further release of oxytocin. The escalating contractions and hormone release continue until the baby is born.

In positive feedback, activity continues until the stimulus is removed or some outside force interrupts the activity.

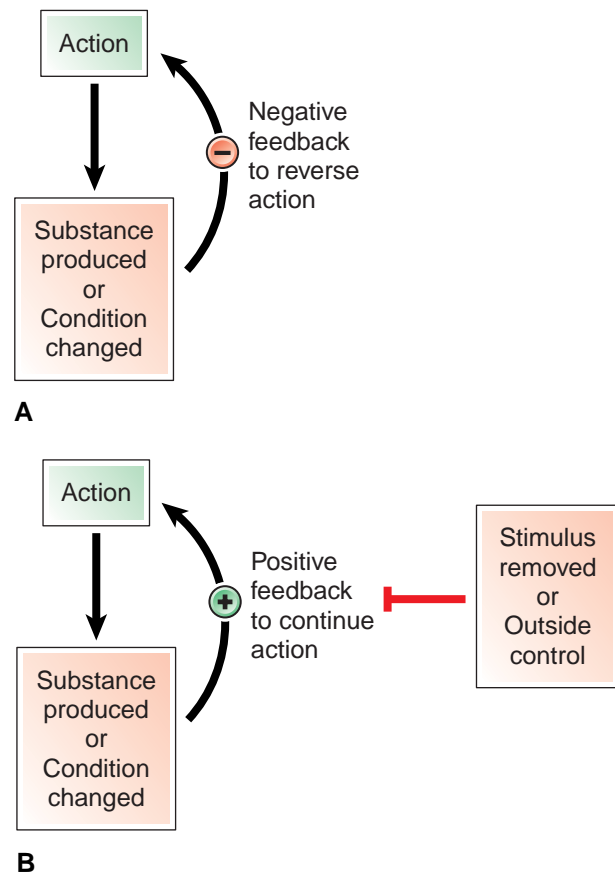


Figure 1-6 Comparison of positive and negative feedback. (A) In negative feedback, the result of an action reverses the action. (B) In positive feedback, the result of an action stimulates further action. Positive feedback continues until the stimulus is removed or an outside force stops the cycle.

Positive and negative feedback are compared in [Figure 1-6](#).

The Effects of Aging

With age, changes occur gradually in all body systems. Some of these changes, such as wrinkles and gray hair, are obvious. Others, such as decreased kidney function, loss of bone mass, and formation of deposits within blood vessels, are not visible. However, they may make a person more subject to injury and disease. Changes due to aging will be described in chapters on the body systems.

Checkpoint 1-2 Metabolism is divided into a breakdown phase and a building phase. What are these two phases called?

Checkpoint 1-3 What type of system is used primarily to maintain homeostasis?

Directions in the Body

Because it would be awkward and inaccurate to speak of bandaging the “southwest part” of the chest, a number of terms are used universally to designate position and directions in the body. For consistency, all descriptions assume that the body is in the **anatomical position**. In this posture, the subject is standing upright with face front, arms at the sides with palms forward, and feet parallel, as shown by the smaller illustration in [Figure 1-7](#).

Directional Terms

The main terms for describing directions in the body are as follows (see [Fig. 1-7](#)):

- ▶ **Superior** is a term meaning above, or in a higher position. Its opposite, **inferior**, means below, or lower. The heart, for example, is superior to the intestine.
- ▶ **Ventral** and **anterior** have the same meaning in humans: located toward the belly surface or front of the body. Their corresponding opposites, **dorsal** and **posterior**, refer to locations nearer the back.
- ▶ **Cranial** means nearer to the head. **Caudal** means nearer to the sacral region of the spinal column (*i.e.*, where the tail is located in lower animals), or, in humans, in an inferior direction.
- ▶ **Medial** means nearer to an imaginary plane that passes through the midline of the body, dividing it into left and right portions. **Lateral**, its opposite, means farther away from the midline, toward the side.
- ▶ **Proximal** means nearer the origin of a structure; **distal**, farther from that point. For example, the part of your thumb where it joins your hand is its proximal region; the tip of the thumb is its distal region.

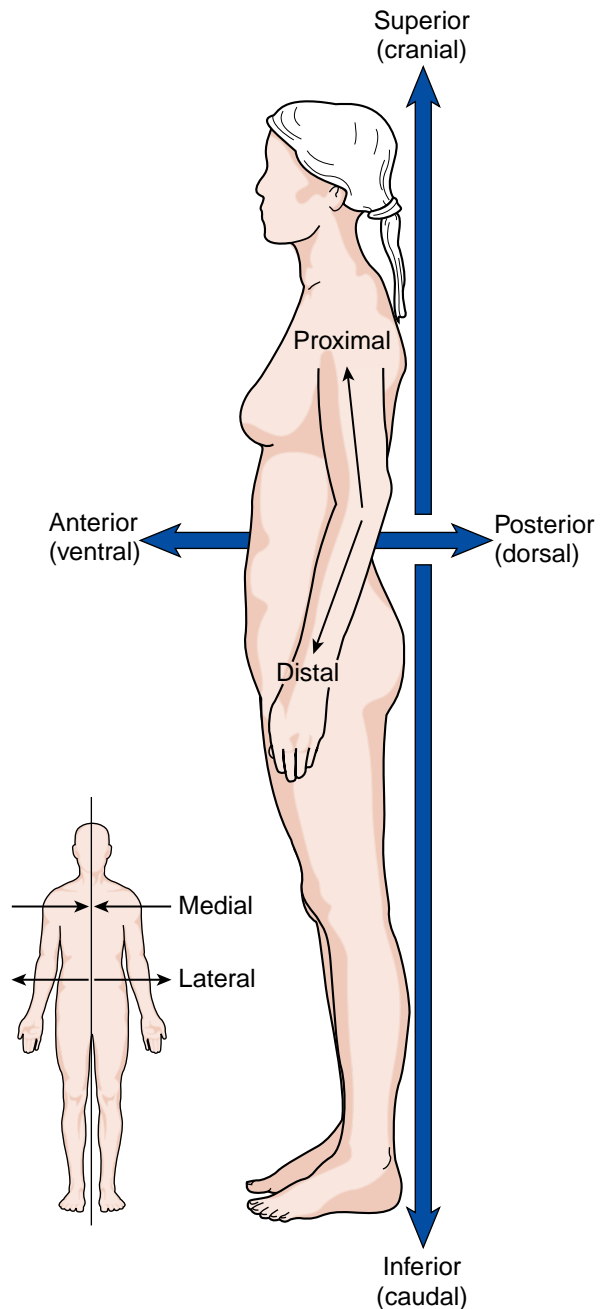


Figure 1-7 Directional terms. **ZOOMING IN** ♦ What is the scientific name for the position in which the small figure is standing?

Planes of Division

To visualize the various internal structures in relation to each other, anatomists can divide the body along three planes, each of which is a cut through the body in a different direction ([Fig. 1-8](#)).

- ▶ The **frontal plane**. If the cut were made in line with the ears and then down the middle of the body, you would see an anterior, or ventral (front), section and a poste-

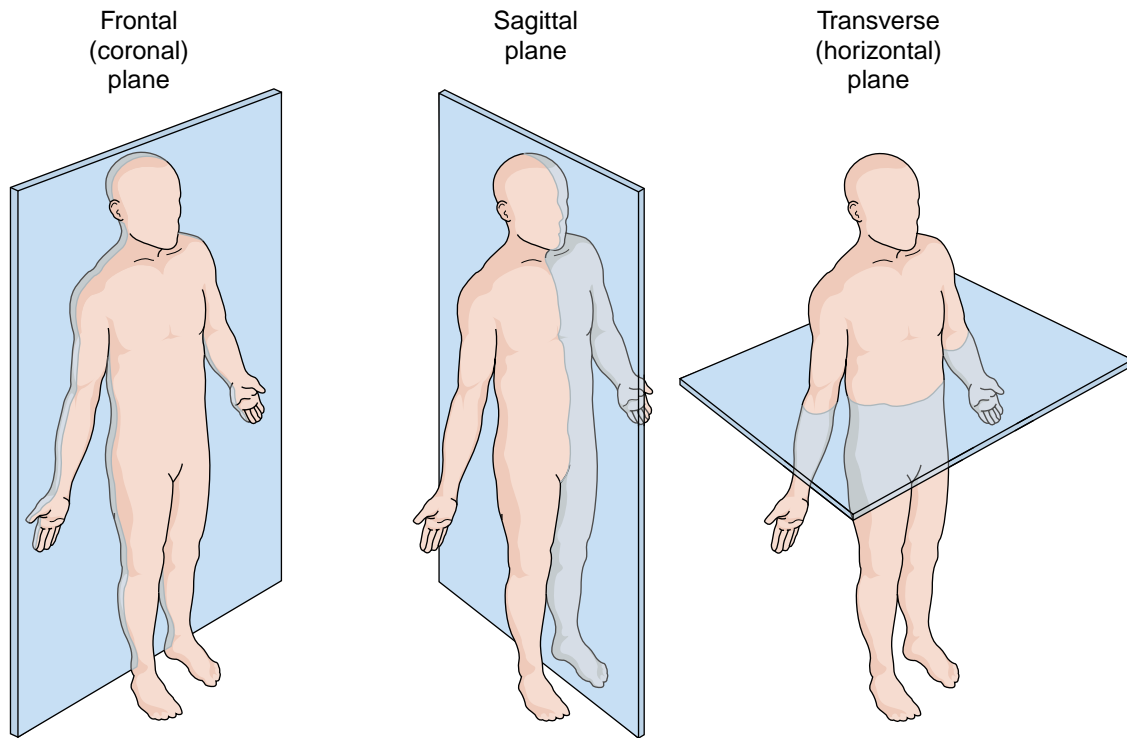


Figure 1-8 Planes of division. ZOOMING IN ♦ Which plane divides the body into superior and inferior parts? Which plane divides the body into anterior and posterior parts?

rior, or dorsal (back), section. Another name for this plane is *coronal plane*.

- ▶ The **sagittal** (SAJ-ih-tal) **plane**. If you were to cut the body in two from front to back, separating it into right and left portions, the sections you would see would be sagittal sections. A cut exactly down the midline of the body, separating it into equal right and left halves, is a **midsagittal** section.
- ▶ The **transverse plane**. If the cut were made horizontally, across the other two planes, it would divide the body into a superior (upper) part and an inferior (lower) part. There could be many such cross-sections,

each of which would be on a transverse plane, also called a *horizontal plane*.

Tissue Sections Some additional terms are used to describe sections (cuts) of tissues, as used to prepare them for study under the microscope (Fig. 1-9). A cross section (see figure) is a cut made perpendicular to the long axis of an organ, such as a cut made across a banana to give a small round slice. A longitudinal section is made parallel to the long axis, as in cutting a banana from tip to tip to make a slice for a banana split. An oblique section

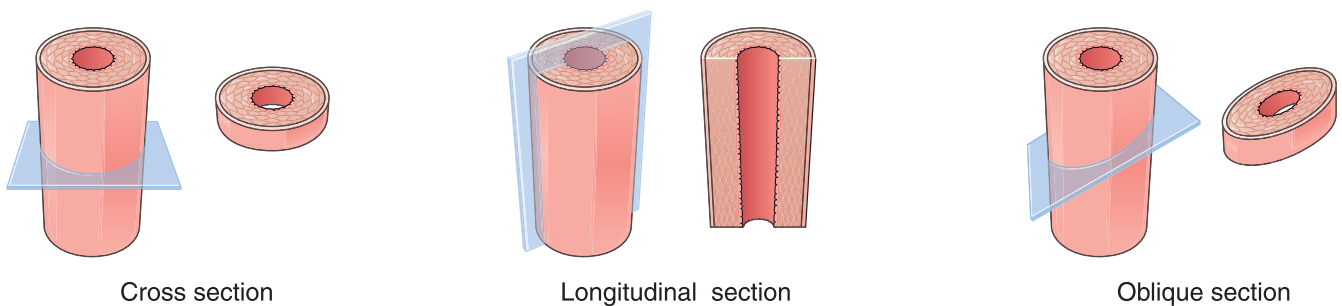


Figure 1-9 Tissue sections.

Medical Imaging: Seeing Without Making a Cut

Three imaging techniques that have revolutionized medicine are radiography, computed tomography, and magnetic resonance imaging. With them, physicians today can “see” inside the body without making a single cut. Each technique is so important that its inventor received a Nobel Prize.

The oldest is radiography (ra-de-OG-rah-fe), in which a machine beams x-rays (a form of radiation) through the body onto a piece of film. Like other forms of radiation, x-rays damage body tissues, but modern equipment uses extremely low doses. The resulting picture is called a radiograph. Dark areas indicate where the beam passed through the body and exposed the film, whereas light areas show where the beam did not pass through. Dense tissues (bone, teeth) absorb most of the x-rays, preventing them from exposing the film. For this reason, radiography is commonly used to visualize bone fractures and tooth decay as well as abnormally dense tissues like tumors. Radiography does not provide clear pictures of soft tissues because most of the beam passes through and exposes the film, but contrast media can help make structures like blood vessels and hollow organs more visible. For example, barium sulfate (which absorbs x-rays) coats the digestive tract when ingested.

Computed tomography (CT) is based on radiography and also uses very low doses of radiation. During a CT scan, a machine revolves around the patient, beaming x-rays through the body onto a detector. The detector takes numerous pictures of the beam and a computer assembles them into transverse sections, or “slices.” Unlike conventional radiography, CT produces clear images of soft structures such as the brain, liver, and lungs. It is commonly used to visualize brain injuries and tumors, and even blood vessels when used with contrast media.

Magnetic resonance imaging uses a strong magnetic field and radiowaves. So far, there is no evidence to suggest that MRI causes tissue damage. The MRI patient lies inside a chamber within a very powerful magnet. The molecules in the patient’s soft tissues align with the magnetic field inside the chamber. When radiowaves beamed at the region to be imaged hit the soft tissue, the aligned molecules emit energy that the MRI machine detects, and a computer converts these signals into a picture. MRI produces even clearer images of soft tissue than does computed tomography and can create detailed pictures of blood vessels without contrast media. MRI can visualize brain injuries and tumors that might be missed using CT.

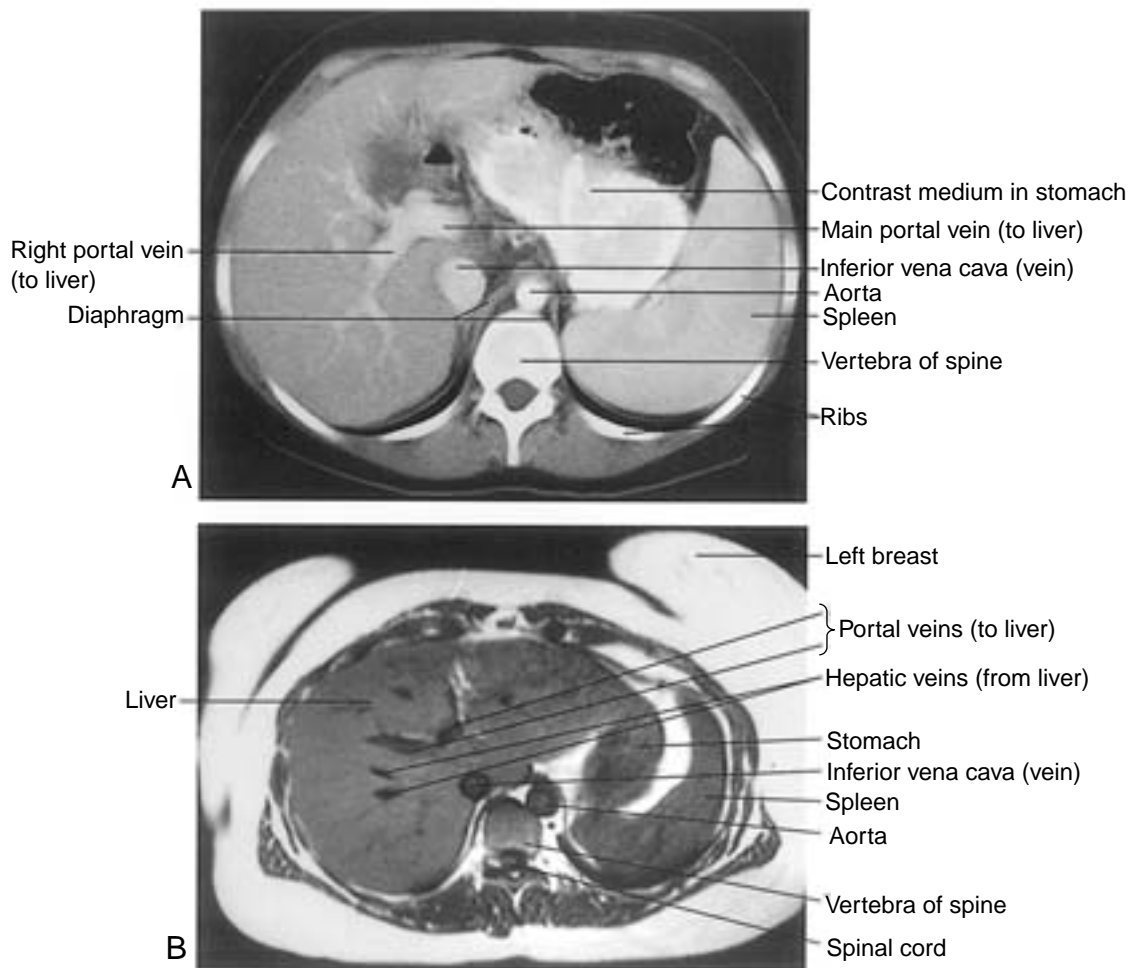


Figure 1-10 Cross-sections in imaging. Images taken across the body through the liver and spleen by (A) computed tomography (CT) and (B) magnetic resonance imaging (MRI). (Reprinted with permission from Erkonen WE. *Radiology 101: Basics and Fundamentals of Imaging*. Philadelphia: Lippincott Williams & Wilkins, 1998.)

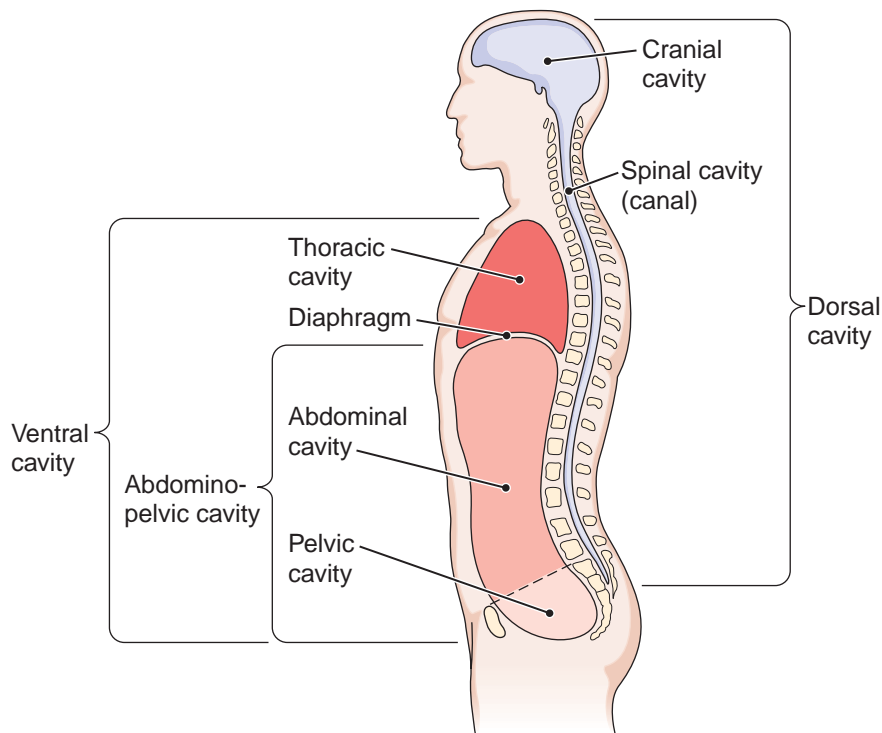


Figure 1-11 Body cavities, lateral view. Shown are the dorsal and ventral cavities with their subdivisions. **ZOOMING IN** ♦ What cavity contains the diaphragm?

Checkpoint 1-4 What are the three planes in which the body can be cut? What kind of a plane divides the body into two equal halves?

is made at an angle. The type of section used will determine what is seen under the microscope, as shown with a blood vessel in [Figure 1-9](#).

These same terms are used for images taken by techniques such as computed tomography (CT) or magnetic resonance imaging (MRI). (See [Box 1-2](#), Medical Imaging: Seeing Without Making a Cut). In imaging studies, the term cross section is used more generally to mean any two-dimensional view of an internal structure obtained by imaging, as shown in [Figure 1-10](#).

Body Cavities

Internally, the body is divided into a few large spaces, or **cavities**, which contain the organs. The two main cavities are the **dorsal cavity** and **ventral cavity** ([Fig. 1-11](#)).

Dorsal Cavity

The dorsal body cavity has two subdivisions: the **cranial cavity**, containing the

brain, and the **spinal cavity (canal)**, enclosing the spinal cord. These two areas form one continuous space.

Ventral Cavity

The ventral cavity is much larger than the dorsal cavity. It has two main subdivisions, which are separated by the **diaphragm** (DI-ah-fram), a muscle used in breathing. The **thoracic** (tho-RAS-ik) cavity is located superior to (above) the diaphragm. Its contents include the heart, the lungs, and the large blood vessels that join the heart. The heart is contained in the pericardial cavity, formed by the pericardial sac; the lungs are in the pleural cavity, formed by the pleurae, the membranes that enclose the lungs ([Fig. 1-12](#)). The **mediastinum** (me-de-as-TI-num) is the space between the lungs, including the organs and vessels contained in that space.

The **abdominopelvic** (ab-dom-ih-no-PEL-vik) cavity (see [Fig. 1-11](#)) is located inferior to (below) the di-

aphragm. This space is further subdivided into two regions. The superior portion, the **abdominal cavity**, contains the stomach, most of the intestine, the liver, the gallbladder, the pancreas, and the spleen. The inferior portion, set off by an imaginary line across the top of the hip bones, is the **pelvic cavity**. This cavity contains the urinary bladder, the rectum, and the internal parts of the reproductive system.

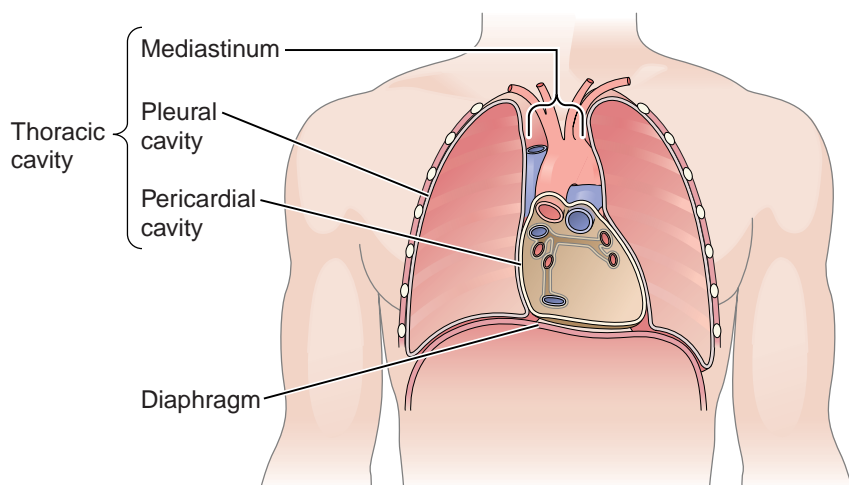


Figure 1-12 The thoracic cavity. Shown are the pericardial cavity, which contains the heart, and the pleural cavity, which contains the lungs.

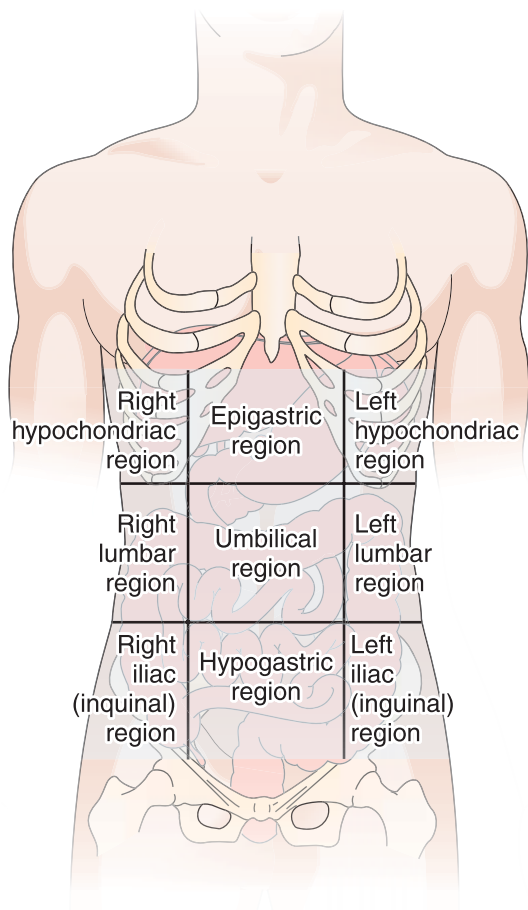


Figure 1-13 The nine regions of the abdomen.

Checkpoint 1-5 There are two main body cavities, one posterior and one anterior. Name these two cavities.

Regions of the Abdomen It is helpful to divide the abdomen for examination and reference into nine regions (Fig. 1-13).

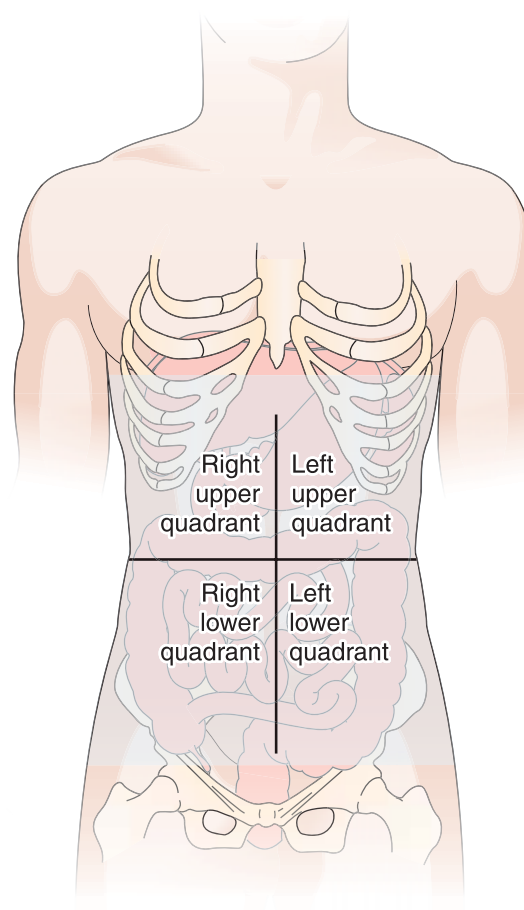


Figure 1-14 Quadrants of the abdomen. The organs within each quadrant are shown.

The three central regions, from superior to inferior are:

- ▶ the **epigastric** (ep-ih-GAS-trik) region, located just inferior to the breastbone
- ▶ the **umbilical** (um-BIL-ih-kal) region around the umbilicus (um-BIL-ih-kus), commonly called the *navel*

Box 1-3 • Health Professions

Health Information Technicians

Every time a patient receives medical treatment, information is added to the patient's medical record, which includes data about symptoms, medical history, test results, diagnoses, and treatment. **Health information technicians** organize and manage these records, working closely with physicians, nurses, and other health professionals to ensure that medical records provide a complete, accurate basis for quality patient care.

Accurate medical records are also essential for administrative purposes. Health information technicians assign a code to each diagnosis and procedure a patient receives, and this information is used for accurate patient billing. In addition, health information technicians analyze medical records to discover trends in health and disease. This research can be used

to improve patient care, manage costs, and help establish new medical treatments.

Health information technicians need a strong clinical knowledge base. A thorough background in medical terminology is essential when reading and interpreting medical records. Anatomy and physiology are definitely required!

Most health information technologists work in hospitals and long-term care facilities. Others work in medical clinics, government agencies, insurance companies, and consulting firms. Job prospects are promising because of the growing need for healthcare. In fact, health information technology is projected to be one of the fastest growing careers in the United States. For more information about this profession, contact the American Health Information Management Association.

- ▶ the **hypogastric** (hi-po-GAS-trik) region, the most inferior of all the midline regions

The regions on the right and left, from superior to inferior, are:

- ▶ the **hypochondriac** (hi-po-KON-dre-ak) regions, just inferior to the ribs
- ▶ the **lumbar** regions, which are on a level with the lumbar regions of the spine
- ▶ the **iliac, or inguinal** (IN-gwih-nal), regions, named for the upper crest of the hipbone and the groin region, respectively

A simpler but less precise division into four quadrants is sometimes used. These regions are the right upper quadrant (RUQ), left upper quadrant (LUQ), right lower quadrant (RLQ), and left lower quadrant (LLQ) (Fig. 1-14). (See Box 1-3, Health Information Technicians, for description of a profession that uses anatomical, physiological, and medical terms)

Checkpoint 1-6 Name the three central regions and the three left and right lateral regions of the abdomen.

▶ The Metric System

Now that we have set the stage for further study of the body's structure and function, we should take a look at the metric system, because this system is used for all scientific measurements. The drug industry and the health-care industry already have converted to the metric system, so anyone who plans a career in healthcare should be acquainted with metrics.

The metric system is like the monetary system in the United States. Both are decimal systems based on multiples of the number 10. One hundred cents equal one dollar; one hundred centimeters equal one meter. Each multiple in the decimal system is indicated by a prefix:

kilo = 1000
centi = 1/100
milli = 1/1000
micro = 1/1,000,000

Units of Length

The basic unit of length in the metric system is the **meter** (m). Using the prefixes above, 1 kilometer is equal to 1000 meters. A centimeter is 1/100 of a meter; stated another way, there are 100 centimeters in 1 meter. The United States has not changed over to the metric system, as was once expected. Often, measurements on packages, bottles, and yard goods are now given according to both

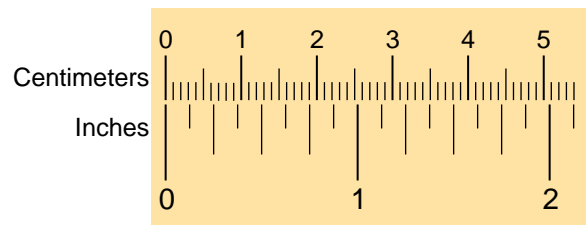


Figure 1-15 Comparison of centimeters and inches.

scales. In this text, equivalents in the more familiar units of inches and feet are included along with the metric units for comparison. There are 2.5 centimeters (cm) or 25 millimeters (mm) in 1 inch, as shown in Figure 1-15. Some equivalents that may help you to appreciate the size of various body parts are as follows:

1 mm = 0.04 inch, or 1 inch = 25 mm

1 cm = 0.4 inch, or 1 inch = 2.5 cm

1 m = 3.3 feet, or 1 foot = 30 cm

Units of Weight

The same prefixes used for linear measurements are used for weights and volumes. The **gram** (g) is the basic unit of weight. Thirty grams are about equal to 1 ounce, and 1 kilogram to 2.2 pounds. Drug dosages are usually stated in grams or milligrams. One thousand milligrams equal 1 gram; a 500-milligram (mg) dose would be the equivalent of 0.5 gram (g), and 250 mg is equal to 0.25 g.

Units of Volume

The dosages of liquid medications are given in units of volume. The basic metric measurement for volume is the **liter** (L) (LE-ter). There are 1000 milliliters (mL) in a liter. A liter is slightly greater than a quart, a liter being equal to 1.06 quarts. For smaller quantities, the milliliter is used most of the time. There are 5 ml in a teaspoon and 15 mL in a tablespoon. A fluid ounce contains 30 mL.

Temperature

The Celsius (centigrade) temperature scale, now in use by most countries and by scientists in this country, is discussed in Chapter 20.

A chart of all the common metric measurements and their equivalents is shown in Appendix 1. A Celsius-Fahrenheit temperature conversion scale appears in Appendix 2.

Checkpoint 1-7 Name the basic units of length, weight, and volume in the metric system.

Word Anatomy

Medical terms are built from standardized word parts (prefixes, roots, and suffixes). Learning the meanings of these parts can help you remember words and interpret unfamiliar terms.

WORD PART	MEANING	EXAMPLE
<i>Studies of the Human Body</i>		
-tomy dis- physi/o path/o	cutting, incision of apart, away from nature, physical disease	<i>Anatomy</i> can be revealed by making incisions in the body. To <i>dissect</i> is to cut apart. <i>Physiology</i> is the study of how the body functions. <i>Pathology</i> is the study of disease.
<i>Body Processes</i>		
cata-	down	<i>Catabolism</i> is the breakdown of complex substances into simpler ones.
ana-	upward, again, back	<i>Anabolism</i> is the building up of simple compounds into more complex substances.
home/o- stat	same stand, stoppage, constancy	<i>Homeostasis</i> is the steady state (sameness) within an organism. In <i>homeostasis</i> , “-stasis” refers to constancy.

Summary

I. Studies of the human body

1. Anatomy—study of structure
 2. Physiology—study of function
 3. Pathology—study of disease
- A. Levels of organization—chemicals, cell, tissue, organ, organ system, whole organism

II. Body systems

1. Integumentary system—skin and associated structures
2. Skeletal system—support
3. Muscular system—movement
4. Nervous system—reception of stimuli and control of responses
5. Endocrine system—production of hormones for regulation of growth, metabolism, reproduction
6. Cardiovascular system—movement of blood for transport
7. Lymphatic system—aids in circulation, immunity, and absorption of digested fats
8. Respiratory system—intake of oxygen and release of carbon dioxide
9. Digestive system—intake, breakdown, and absorption of nutrients
10. Urinary system—elimination of waste and water
11. Reproductive system—production of offspring

III. Metabolism and its regulation

1. Metabolism—all the chemical reactions needed to sustain life
2. Catabolism—breakdown of complex substances into simpler substances; release of energy from nutrients
 - a. ATP (adenosine triphosphate)—energy compound of cells
3. Anabolism—building of body materials

A. Homeostasis—steady state of body conditions

1. Fluid balance
 - a. Extracellular fluid—outside the cells
 - b. Intracellular fluid—inside the cells
2. Feedback—regulation by return of information within a system
 - a. Negative feedback—reverses an action
 - b. Positive feedback—promotes continued activity

B. Effects of aging—changes in all systems

IV. Directions in the body

1. Anatomical position—upright, palms forward, face front, feet parallel
- A. Directional terms
1. Superior—above or higher; inferior—below or lower
 2. Ventral (anterior)—toward belly or front surface; dorsal (posterior)—nearer to back surface
 3. Cranial—nearer to head; caudal—nearer to sacrum
 4. Medial—toward midline; lateral—toward side
 5. Proximal—nearer to point of origin; distal—farther from point of origin
- B. Planes of division
1. Body divisions
 - a. Sagittal—from front to back, dividing the body into left and right parts
 - (1) Midsagittal—exactly down the midline
 - b. Frontal (coronal)—from left to right, dividing the body into anterior and posterior parts
 - c. Transverse—horizontally, dividing the body into superior and inferior parts
 2. Tissue sections
 - a. Cross section—perpendicular to long axis
 - b. Transverse section—parallel to long axis
 - c. Oblique section—at an angle

V. Body cavities

- A.** Dorsal cavity—contains cranial and spinal cavities for brain and spinal cord
- B.** Ventral cavity
- 1.** Thoracic—chest cavity
 - a. Divided from abdominal cavity by diaphragm
 - b. Contains heart and lungs
 - c. Mediastinum—space between lungs and the organs contained in that space
 - 2.** Abdominopelvic
 - a. Abdominal—upper region containing stomach, most of intestine, pancreas, liver, spleen, and others
 - b. Pelvic—lower region containing reproductive organs, urinary bladder, rectum
 - c. Nine regions of the abdomen
 - (1) Central—epigastric, umbilical, hypogastric
 - (2) Lateral (right and left)—hypochondriac, lumbar, iliac (inguinal)
 - d. Quadrants—abdomen divided into four regions

VI. The metric system—based on multiples of 10

- 1.** Basic units
 - a. Meter—length
 - b. Gram—weight
 - c. Liter—volume
 - 2.** Prefixes—indicate multiples of 10
 - a. Kilo—1000 times
 - b. Centi—1/100th (0.01)
 - c. Milli—1/1000th (0.001)
 - d. Micro—1/1,000,000 (0.000001)
- A.** Units of length
B. Units of weight
C. Units of volume
D. Temperature—measured in Celsius (centigrade) scale

Questions for Study and Review**Building Understanding****Fill in the blanks**

1. Tissues may function together as _____.
2. Glands that produce hormones belong to the _____ system.
3. The eyes are located _____ to the nose.
4. Normal body function maintains a state of internal balance called _____.
5. The basic unit of volume in the metric system is the _____.

Matching

Match each numbered item with the most closely related lettered item.

- | | |
|---|--------------------------|
| ___ 6. One of two systems that control and coordinate other systems | a. nervous system |
| ___ 7. The system that brings needed substances to the body tissues | b. abdominal cavity |
| ___ 8. The system that converts foods into a form that body cells can use | c. cardiovascular system |
| ___ 9. The cavity that contains the liver | d. pelvic cavity |
| ___ 10. The cavity that contains the urinary bladder | e. digestive system |

Multiple choice

- ___ 11. The study of normal body structure is
 - a. homeostasis
 - b. anatomy
 - c. physiology
 - d. pathology
- ___ 12. Fluids contained within cells are described as
 - a. intracellular
 - b. ventral
 - c. extracellular
 - d. dorsal
- ___ 13. A type of feedback in which a given action promotes more of the same is called
 - a. homeostasis
 - b. biofeedback
 - c. positive feedback
 - d. negative feedback
- ___ 14. The cavity that contains the mediastinum is the
 - a. dorsal
 - b. ventral
 - c. abdominal
 - d. pelvic
- ___ 15. The foot is located _____ to the knee.
 - a. superior
 - b. inferior
 - c. proximal
 - d. distal

Understanding Concepts

16. Compare and contrast the studies of anatomy and physiology. Would it be wise to study one without the other?
17. List in sequence the levels of organization in the body from simplest to most complex. Give an example for each level.

18. Compare and contrast the anatomy and physiology of the nervous system with that of the endocrine system.
19. What is ATP? What type of metabolic activity releases the energy used to make ATP?
20. Compare and contrast intracellular and extracellular fluids.
21. Explain how an internal state of balance is maintained in the body.
22. List the subdivisions of the dorsal and ventral cavities. Name some organs found in each subdivision.

Conceptual Thinking

23. The human body is organized from very simple levels to more complex levels. With this in mind describe why a disease at the chemical level can have an effect on organ system function.
24. When glucose levels in the blood drop below normal the pancreas releases a hormone called glucagon. Using your understanding of negative feedback, discuss the possible role of glucagon in blood glucose homeostasis.
25. Your patient's chart reads: "Patient reports pain in right lower quadrant of abdomen. X-ray reveals mass in right iliac region." Locate this region on yourself and explain why it is important for health professionals to use anatomical terminology when describing the human body.